

PATENT
Attorney Docket No.: INTEL/16652

This listing of claims will replace all prior versions, and listings, of claims in the application:

The Status of the Claims

1. (Original) An apparatus comprising:
a substrate;
a waveguide mounted on the substrate; and
an optoelectronic chip bonded to the substrate and having an optical element directly engaging the waveguide.

2. (Original) An apparatus as defined in claim 1, wherein the optoelectronic chip is a flip-chip.

3. (Original) An apparatus as defined in claim 1, wherein the optical element comprises a transceiver, a receiver or a transmitter.

4. (Original) An apparatus as defined in claim 1, wherein the optoelectronic chip is bonded to the substrate via an electrical connection between facing surfaces of the optoelectronic chip and the substrate.

5. (Original) An apparatus as defined in claim 1, further comprising an underfill material disposed between the optoelectronic chip and the substrate.

6. (Original) An apparatus as defined in claim 1, wherein the underfill is not disposed between the optical element and the waveguide.

7. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a mirror.

8. (Original) An apparatus as defined in claim 7, wherein the mirror includes a metallized mirror.

9. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a volume diffraction grating.

10. (Original) An apparatus as defined in claim 1, wherein the waveguide includes a planar waveguide.

11. (Original) An apparatus comprising:
a substrate;
a flip-chip having an optical element;
a waveguide at least partially disposed between the substrate and the flip-chip, the waveguide having a thermal stability sufficient to withstand a flip-chip bonding temperature; and
solder bumps to couple the flip-chip to the substrate such that the optical element engages the waveguide.

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12. (Original) An apparatus as defined in claim 11, wherein facing surfaces of the flip-chip and the substrate are electrically connected.

13. (Original) An apparatus as defined in claim 11, wherein a tension force associated with the solder bumps draws the flip-chip and the substrate together when the solder bumps are soldered.

14. (Original) An apparatus as defined in claim 13, wherein the tension force causes the flip-chip to engage the waveguide.

15. (Original) An apparatus as defined in claim 13, wherein the tension force causes the optical element to directly engage the waveguide.

16. (Original) An apparatus as defined in claim 11, wherein the flip-chip is positioned on the substrate using a thermocompression bonder in a z-axis distance control mode.

17. (Original) An apparatus as defined in claim 16, wherein the thermocompression bonder causes the flip-chip to directly engage the waveguide.

18. (Original) An apparatus as defined in claim 16, wherein the thermocompression bonder causes the optical element to directly engage the waveguide.

19. (Original) An apparatus comprising;
a substrate having a first plurality of solder bumps;
a waveguide mounted to the substrate; and
a flip-chip having an optical element and a second plurality of solder bumps, the first
and second plurality of solder bumps having a combined thickness prior to soldering which is
greater than a height of the waveguide.

20. (Original) An apparatus as defined in claim 19, wherein, after soldering,
the combined thickness is approximately equal to the height of the waveguide.

21. (Original) An apparatus as defined in claim 19, wherein the waveguide
has a glass transition temperature above the melting point of the solder bumps.

22. (Original) An apparatus as defined in claim 19, wherein the substrate
includes a FCPGA substrate.

23. (Original) An apparatus comprising;
a substrate;
a flip-chip coupled to the substrate;
an optically active waveguide mounted to the substrate and directly engaging the flip-
chip; and,
a passive waveguide located to maintain a predetermined separation between the flip-
chip and the substrate.

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24. (Original) An apparatus as defined in claim 23, wherein the active waveguide and the passive waveguide are separate waveguides.

25. (Original) An apparatus as defined in claim 23, wherein the active waveguide and the passive waveguide are integrally formed.

26-44. (Cancelled)